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(54) **PRINTED MONOPOLE ANTENNA**

GEDRUCKTE MONOPOLANTENNE

ANTENNE UNIPOLAIRE IMPRIMEE

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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to monopole antennas for radiating and receiving electromagnetic signals and, more particularly, to a printed monopole antenna including a conductive element which defines an extended ground plane to prevent the radiation of currents from a portion of the printed monopole radiating element.

2. Description of Related Art

[0002] With respect to portable radios, cellular telephones, and other communication equipment, it has been found that a monopole antenna mounted perpendicularly to a conducting surface provides an antenna having good radiation characteristics, desirable drive point impedance, and relatively simple construction. Moreover, as compared with a dipole antenna, the monopole antenna is smaller in size and may be viewed as an asymmetric dipole antenna in which the monopole radiating element is one element and a radio case or the like is the other element. Because reduction in size is a desirable characteristic, certain monopole designs, such as the helical configuration disclosed in U.S. Patent 5,231,412 to Eberhardt et al., have been utilized. By doing so, the physical length of the radiating element is significantly less than a corresponding straight wire radiator, but exhibits the same effective electrical length.

[0003] Nevertheless, reduction of physical size reduces the operating radiation bandwidth of an antenna due to changes in the input impedance over frequency. This reduction in bandwidth results from the combination of lower radiation resistance due to smaller antenna size and of a larger amount of stored energy, causing a high Q and low radiation bandwidth. In order to overcome this problem of reduction in operating radiation bandwidth, it has been found that a sleeve surrounding the monopole radiating element is able to extend the ground plane and therefore produce a virtual feedpoint at a designated location along the radiating element. This extension of the ground plane then has the effect of extending the radiation bandwidth, as seen in U.S. Patent No. 5,231,412 and Japanese Patent No. 53-82246 to Takahashi.

[0004] Although helical radiating elements and corresponding sleeves therearound have been generally effective for their intended purpose, it has been difficult to manufacture such antennas within strict tolerance requirements. Moreover, even though such antennas have been able to reduce the physical length of such antennas, they have had the adverse effect of inherently increasing the diameters thereof. Accordingly, it would be desirable to develop a monopole antenna which is able to reduce the overall size thereof instead of just the physical length, as well as one which may be produced in a very precise fashion. Moreover, it would be desirable for such a monopole antenna to require a reactive element which is positioned only adjacent to one side of a portion of the radiating element, thereby eliminating the requirement for such reactive element to encircle the radiating element.

[0005] WO-91/05374 describes a broadband monopole antenna having a radiating element extending vertically with respect to a horizontal ground plane having upper and lower conductive sheets formed on opposite faces of a dielectric substrate. The two conductive sheets are separated by a slot parallel to the ground plane. The capacitance of that slot is used to maintain a low input impedance for the antenna over a wide frequency range. DE 4324480 describes an aerial arrangement with a monopole aerial having a radiator and a counterweight, in which the radiator and the counterweight are each connected at opposite feed points to one conductor of a lead. EP 0 616 383 describes a half-wave dipole antenna arranged on one side of a single printed circuit board having two arms which are of equal length arranged on the edge of the board.

[0006] In light of the foregoing, a primary object of the present invention is to provide a monopole antenna having a configuration which increases the operating radiation bandwidth thereof.

[0007] Another object of the present invention is to provide a monopole antenna having a configuration which reduces the overall size thereof.

[0008] Yet another object of the present invention is to provide a monopole antenna with a conductive element which extends the ground plane, where the size of the reactive element is minimized.

[0009] A further object of the present invention is to provide a monopole antenna which can be constructed within very tight tolerances.

[0010] Another object of the present invention is to provide a monopole antenna having a virtual feedpoint from the end of a conductive element that defines an extended ground plane.

[0011] A further object of the present invention is to provide a printed monopole antenna constructed on a printed circuit board.

[0012] Still another object of the present invention is to provide a printed monopole antenna in which the radiating element is configured to have a physical length less than its electrical length.

[0013] Another object of the present invention is to provide a printed monopole antenna which is operable within two separate frequency bandwidths.

[0014] Yet another object of the present invention is to provide a printed monopole antenna which operates as a half-wavelength antenna at a frequency within a first frequency bandwidth and as a quarter-wavelength or half-wavelength antenna at a frequency within a second frequency bandwidth.

[0015] These objects and other features of the present invention will become more readily apparent upon reference to the following description when taken in conjunction with the following drawing.

SUMMARY OF THE INVENTION

[0016] In accordance with one aspect of the present invention, a printed monopole antenna is disclosed having a printed circuit board with a first side and a second side, a monopole radiating element comprising a first narrow conductive trace formed on the printed circuit board first side, the first, thin conductive trace having a physical length from a feed end to an opposite end, and a conductive element comprising a second conductive trace wider than the first conductive trace formed on the printed circuit board adjacent, in parallel with, and overlapping a substantial portion of the first narrow conductive trace. The second conductive trace has a physical length from a grounding end to an opposite end. The second conductive trace extends the ground plane above the feed end of the first narrow conductive trace. The opposite end of the second conductive trace defines a virtual feedpoint of the monopole radiating element thereby increasing the bandwidth within which the monopole radiating element resonates. The conductive element defines an extended ground plane which prevents the radiation of currents from that portion of the first conductive trace adjacent the second conductive trace. The second conductive trace may be formed on the same side of the printed circuit board as the first conductive trace or on the opposite side. The second conductive trace may also be formed on either or both sides of the first conductive trace.

[0017] In accordance with further aspects of the present invention, a third conductive trace is formed, either on an adjacent printed circuit board or adjacent to the first conductive trace on the printed circuit board first side, in order to permit the printed monopole antenna to operate within two separate frequency bandwidths. Alternatively, a parasitic element may be positioned on the printed circuit board second side at an end opposite the reactive element to permit dual frequency band operation of the printed monopole antenna.

BRIEF DESCRIPTION OF THE DRAWING

[0018] While the specification concludes with claims particularly pointing out and distinctly claiming the present invention, it is believed that the same will be better understood from the following description taken in conjunction with the accompanying drawing in which:

Fig. 1 is a schematic left side view of a printed monopole antenna in accordance with the present invention;
Fig. 2 is a schematic right side view of the printed monopole antenna depicted in Fig. 1;
Fig. 3 is an exploded schematic side view of the printed monopole antenna depicted in Figs. 1 and 2;
Fig. 4 is a schematic view of the printed monopole antenna depicted in Figs. 1 and 2 mounted on a radio transceiver after it has been overmolded;
Fig. 5 is a schematic left side view of an alternative embodiment for the printed monopole antenna of the present invention;
Fig. 6 is an exploded schematic side view of a printed monopole antenna operable within two separate frequency bandwidths, where the radiating element is two conductive traces formed on separate printed circuit boards;
Fig. 7 is an exploded schematic side view of alternative configuration for a printed monopole antenna which is operable within two separate frequency bandwidths, where the radiating element is two conductive traces formed on the same side of a single printed circuit board; and
Fig. 8 is an exploded schematic side view of another alternative configuration for a printed monopole antenna operable within two separate frequency bandwidths, where the radiating element is a single conductive trace formed on one side of a printed circuit board which is tuned by a parasitic element on the opposite side of the printed circuit board.

DETAILED DESCRIPTION OF THE INVENTION

[0019] Referring now to the drawings in detail, wherein identical numerals indicate the same elements throughout the figures, Figs. 1-4 depict a printed monopole antenna 10 of the type utilized with radio transceivers, cellular telephones, and other personal communications equipment having a single frequency bandwidth of operation. As seen in Figs. 1-3, printed monopole antenna 10 includes a printed circuit board 12, which preferably is planar in configuration having a first side 14 (Fig. 1) and a second side 16 (Fig. 2). It will be noted that printed monopole antenna 10 includes a monopole radiating element in the form of a first conductive trace 18 formed on first side 14 of printed circuit board 12. In addition, a conductive element in the form of a second conductive trace 20 is formed on second side 16 of printed circuit board 12. Second conductive trace 20 defines an extended ground plane 21 (denoted by a dashed line) which prevents the radiation of currents from printed monopole antenna 10 over that portion of first conductive trace 18 aligned with second conductive trace 20. In this way, a virtual feedpoint 22 is defined for printed monopole antenna 10 along extended ground plane 21.

[0020] More specifically, it will be seen that printed circuit board 12, which acts as a supporting surface, is preferably sized to accommodate first conductive trace 18. Accordingly, printed circuit board 12 includes a first rectangular section 24 adjacent a feed end 26 of antenna 10 and a second rectangular section 28 extending from first rectangular section 24 away from feed end 26.

It will also be understood that printed circuit board 12 is made of a dielectric material, and optimally a flexible dielectric material in order to permit some degree of flexing or bending without breakage. Examples of flexible dielectric material which may be utilized include polyamide and polyester film from conductive materials (e.g., copper) and conductive inks.

[0021] With respect to the radiating element of printed monopole antenna 10, first conductive trace 18 is formed on first side 14 of the printed circuit board 12 by film photo-imaging processes or other known techniques. Due to the equipment available for performing this task, adherence to strict size and design tolerances is permitted. First conductive trace 18 may be linear in configuration along printed circuit board 12, but it is preferred that at least a portion thereof be non-linear as identified generally by numeral 30. In this regard, first conductive trace 18 has a physical length l_1, with a feed end 32 and an opposite end 34. Feed end 32, which may be directly connected to the main control circuit for a radio transceiver, cellular telephone, or other communication device, preferably is coupled to a signal feed portion 36 of a feed port 38 (e.g., a coaxial connector).

[0022] As seen in Figs. 1 and 3, non-linear portion 30 of first conductive trace 18 has a crank or square-wave type configuration. As such, non-linear portion 30 has what may be termed a duty cycle 40 defined as the distance between forward edges of adjacent cranks (see Fig. 3). While duty cycle 40 depicted in Figs. 1 and 3 remains substantially constant, the actual distance between cranks, as well as the pattern utilized, may be modified according to the needs of a specific application. In this way, first conductive trace 18 may be configured to have an electrical length approximately equivalent to a quarter-wavelength or half-wavelength for a desired center frequency of antenna operation, as well as another other desired size. Further detail for the design of conductive traces is found in U.S. Patent Application Serial No. 08/459,959, titled "Antenna Having Electrical Length Greater Than Its Physical Length," filed concurrently herewith, which is owned by the assignee of the present invention.

[0023] With respect to second conductive trace 20 formed on second side 16 of printed circuit board 12, it will be noted that it has a physical length l_2 which extends from a grounding end 42 to an opposite end 44 (see Fig. 3). It will be understood that physical length l_2 of second conductive trace 20 defines the distance in which the ground plane of printed monopole antenna 10 is extended. Therefore, it is at opposite end 44 thereof that extended ground plane 21 and virtual feedpoint 22 of printed monopole antenna 10 is located. It is a feature of the present invention that second conductive trace 20 acts to increase the bandwidth within which first conductive trace 18 will be resonant. For example, bandwidths of approximately an octive have been achieved (i.e., where the high end of the frequency band is approximately twice the low end of the frequency band). This is a marked improvement of bandwidths currently achieved ranging between 5-10% of the center frequency. Further, it will be recognized that the increased bandwidth need not be equally distributed higher and lower of the center frequency, such as when the antenna is sized near a half-wavelength of the center frequency.

[0024] Grounding end 42 of second conductive trace 20 is preferably coupled to a ground portion 46 of feed port 38. Accordingly, it will be noted that grounding end 42 of second conductive trace 20 is adjacent feed end 32 of first conductive trace 18. Second conductive trace 20 is shown as being formed entirely within first rectangular section 24 of printed circuit board second side 16 (although second conductive trace 20 could extend into second rectangular section 28 of printed circuit board 12), where it functions to prevent the radiation of currents from non-linear portion 30 of first conductive trace 18 aligned therewith. Although not shown, second conductive trace 20 could also be wrapped around the feed end of printed circuit board 12 and extend onto first side 14 thereof. Accordingly, due to the planar configuration of printed monopole antenna 10, the physical length of the radiating element (first conductive trace 18) is reduced, as well as the overall size of the conductive element (second conductive trace 20).

[0025] As is well known, the electrical length of an antenna's radiating element determines the center frequency of desired antenna operation. While the electrical length of first conductive trace 18 may be equivalent to physical length l_1 thereof when it has a linear configuration, it will be understood that the electrical length of first conductive trace 18 will be greater than physical length l_1 when it includes a non-linear portion such as that shown at 30. Preferably, first conductive trace 18 will have an electrical length which corresponds to either a quarter-wavelength or a half-wavelength for a desired center frequency. In order to provide an impedance match for broadband operation of printed monopole antenna 10, which generally is targeted at 50 ohms, the electrical length of second conductive trace 20 is sized accordingly with respect to the electrical length of first conductive trace 18.

[0026] As seen in Fig. 4, printed monopole antenna 10 is coupled to a radio transceiver 48 such as by feed port 38. In order to protect printed monopole antenna 10 from environmental factors, as well as provide a more aesthetically pleasing appearance, it is preferred that printed monopole antenna 10 be overmolded by rubberizing the outside of printed monopole antenna 10 or otherwise coating it with molded material having a low dielectric loss. For further detail on the construction of printed monopole antenna 10, see U.S. Patent No. 5,709,832 entitled "Method of Manufacturing A Printed Antenna," filed concurrently herewith, which is also owned by the assignee of the present invention.

[0027] As seen in Fig. 5, second conductive trace 20 may alternatively be formed on first side 14 of printed circuit board 12 adjacent first conductive trace 18. Sec-

ond conductive trace 20 will function as described previously herein with respect to the embodiment depicted in Figs. 1-3 to form extended ground plane 21 and virtual feed point 22 of printed monopole antenna 10. Although depicted as being positioned to each side of first conductive trace 18 in Fig. 5, it will be understood that second conductive trace 20 may be positioned to only one side thereof.

[0028] In order to permit printed monopole antenna 10 to operate within dual frequency bands, a second radiating element in the form of a third conductive trace 50 may be provided as described in more detail in U.S. Patent Application Serial No. 08/459,553 entitled "Multiple Band Printed Monopole Antenna," filed concurrently herewith, which is owned by the assignee of the present invention. As will be seen in Fig. 6, third conductive trace 50 is formed on a side 54 of a second printed circuit board 52 opposite first conductive trace 18. Preferably, third conductive trace 50 has a physical length l_3 substantially equivalent to physical length l_1 of first conductive trace 18. However, it will be seen that third conductive trace 50 will have an electrical length less than that of first conductive trace 18 since it has an entirely linear configuration. In order to better separate the respective frequency bands radiated by first conductive trace 18 and third conductive trace 50, first conductive trace 18 may entirely have a non-linear configuration (e.g., the crank or square wave type disclosed herein), which provides a greater distinction in the respective electrical lengths of first and third conductive traces 18 and 50, respectively. In this regard, it may be preferred for first conductive trace 18, which will be resonant within a lower frequency band, to have an electrical length equivalent to a half-wavelength or a quarter-wavelength of a first desired center frequency and third conductive trace 50, which will be resonant within a higher frequency band, to have an electrical length equivalent to a half-wavelength of a second desired center frequency.

[0029] It will be seen from Figs. 6 and 7 that first conductive trace 18 behaves as the principle radiating element with a direct contact to a radio transceiver, cellular telephone, or other communication device. Second conductive trace 20, which performs the function of a conductive element, enhances the performance within both frequency bands radiated by first and third conductive traces 18 and 50. Since the presence of third conductive trace 50 has little effect on first conductive trace 18, an optimized response can be achieved for both frequency bands of operation.

[0030] An alternative configuration for printed monopole antenna 10 being operable over a dual frequency band is shown in Fig. 7 and described in more detail in the aforementioned patent application entitled "Multiple Band Printed Monopole Antenna." As seen therein, third conductive trace 50 is located adjacent first conductive trace 18 on first side 14 of printed circuit board 12. Other than being located on the same printed circuit board adjacent to first conductive trace 18, third conductive trace 50 has the same physical characteristics as that described above and functions in the same manner.

[0031] A further alternative configuration for a printed monopole antenna 10 to be operated over two separate frequency bands is shown in Fig. 8 and described in detail in U.S. Patent Application Serial No. 08/459,553 entitled "Multiple Band Printed Monopole Antenna," filed concurrently herewith, which is also owned by the assignee of the present invention. In this design, a parasitic element 56 is provided on second side 16 of printed circuit board 12 at an end opposite second conductive trace 20. Parasitic element 56, such as a copper strip, is used to tune the secondary resonance of first conductive trace 18 so that a second frequency band (other than an integer multiple of the frequency band radiated by first conductive trace 18 at primary resonance) is produced. It will be understood that the configuration of Fig. 8 employing parasitic element 56 is based on the same printed monopole antenna 10 described hereinabove, as is that shown with the configurations depicted in Figs. 6 and 7.

Claims

1. A printed monopole antenna (10) having a ground plane (21) defined substantially perpendicular thereto including:

   (a) a printed circuit board (12) having a first side (14) and a second side (16);
   (b) a monopole radiating element including a first conductive trace (18) formed on said printed circuit board first side, said first narrow conductive trace having a physical length from a feed end to an opposite end; and
   (c) a conductive element including a second conductive trace (20) wider than said first narrow conductive trace formed on said printed circuit board adjacent, in parallel with, and overlapping a substantial portion of said first narrow conductive trace, said second conductive trace having a physical length from a grounding end to an opposite end;

   wherein said second conductive trace extends the ground plane above the feed end (26) of the first narrow conductive trace and wherein the opposite end of said second conductive trace defines a virtual feedpoint (26) of said monopole radiating element thereby"increasing the bandwidth within which said monopole radiating element resonates.

2. The printed monopole antenna of claim 1, wherein said second conductive trace is formed on said printed circuit board second side.

3. The printed monopole antenna of claim 1, wherein said second conductive trace is formed on said printed circuit board first side.

4. The printed monopole antenna of claim 1, wherein said second conductive trace prevents currents from radiating over the substantial portion of said first conductive trace overlapping said second conductive trace.

5. The printed monopole antenna of claim 1, wherein said printed circuit board is made of a flexible dielectric material.

6. The printed monopole antenna of claim 1, wherein the electrical length of said first conductive trace defines the center frequency of antenna operation within a first frequency band.

7. The printed monopole antenna of claim 1, wherein said physical length of said second conductive trace determines the impedance match for broadband operation of said antenna.

8. The printed monopole antenna of claim 1, wherein said printed circuit board, said first conductive trace, and said second conductive trace are overmolded.

9. The printed monopole antenna of claim 1, wherein the substantial portion of said first conductive trace is non-linear, whereby said physical length of said first conductive trace is less than an electrical length for said first conductive trace.

10. The printed monopole antenna of claim 9, said non-linear portion of said first conductive trace having a square wave configuration.

11. The printed monopole antenna of claim 1, further including a feed port (38) including a signal feed portion (36) and a ground portion (46), said signal feed portion being coupled to said feed end of said first conductive trace and said ground portion being coupled to said grounding end of said second conductive trace.

12. The printed monopole antenna of claim 11, wherein said feed port comprises a coaxial connector.

13. The printed monopole antenna of claim 1, wherein said monopole radiating element has an electrical length substantially equivalent to said physical length of said first conductive trace.

14. The printed monopole antenna of claim 1, wherein the physical length of said second conductive trace is less than the physical length of said first conductive trace.

15. The printed monopole antenna of claim 1, wherein the electrical length of said first conductive trace is approximately equivalent to the quarter-wavelength of a desired center frequency for antenna operation.

16. The printed monopole antenna of claim 1, wherein an electrical length of said first conductive trace is approximately equivalent to a half-wavelength of a desired center frequency for antenna operation.

17. The printed monopole antenna of claim 1, further including:

(a) a second printed circuit board (52) having a first side (54) and a second side, said second printed circuit board being spaced from said first printed board so that said first printed circuit board first side is adjacent said second printed circuit board second side; and
(b) a third conductive trace (50) formed on said second printed circuit board first side;

wherein said first conductive trace has an electrical length resonant within a first frequency band and said third conductive trace has an electrical length resonant within a second frequency band.

18. The printed monopole antenna of claim 1, further including a third conductive trace (50) formed on said printed circuit board first side adjacent said first conductive trace, wherein said first conductive trace has an electrical length resonant within a first frequency band and said third conductive trace has an electrical length resonant within a second frequency band.

19. The printed monopole antenna of claim 1, further including a parasitic element (56) formed on said printed circuit board second side, said parasitic element being located at said end opposite said second conductive trace, wherein said first conductive trace has an electrical length resonant within a first frequency band and said parasitic element tunes said first conductive trace to a secondary resonance within a second frequency band.

20. An antenna (10) for a communication device, a housing (48) for said communication device defining a ground plane (21) including:

(a) a feed port (36) including a signal feed portion (36) and a ground portion (46);
(b) a printed circuit board (12) having a first side (14) and a second side (16);
(c) a monopole radiating element including a first narrow conductive trace (18) formed on said printed circuit board first side, said first nar-

row conductive trace having a physical length from a feed end coupled to said signal feed portion of said feed port to an opposite end;
(d) a conductive element including a second conductive trace (20) wider than the first narrow conductive trace formed on said printed circuit board in parallel with and overlapping a portion of said first narrow conductive trace, said second conductive trace having a physical length from a grounding end coupled to said ground portion of said feed port to an opposite end, wherein said grounding end of said second conductive trace is located at the same end as said feed end of said first conductive trace;

wherein said second conductive trace extends the ground plane above the feed end (26) of said first narrow conductive trace and wherein an opposite end of said second conductive trace defines a virtual feedpoint (22) of the antenna thereby increasing the bandwidth within which said monopole radiating element resonates.

21. The antenna of claim 20, wherein said second conductive trace prevents currents from radiating over that portion of said first conductive trace aligned with said second conductive trace.

22. The antenna of claim 20, wherein said second conductive trace is formed on said printed circuit board second side.

23. The antenna of claim 20, wherein said second conductive trace is sized to provide an impedance match with said first conductive trace.

24. The antenna of claim 20, wherein the physical length of said second conductive trace is sized to provide an impedance match with said first conductive trace.

25. The antenna of claim 20, wherein that portion of said first conductive trace aligned with said second conductive trace is non-linear.

Patentansprüche

1. Gedruckte Monopolantenne (10) mit einer Masseebene (21), die im wesentlichen senkrecht dazu definiert ist einschließlich:

(a) einer Leiterplatte (12) mit einer ersten Seite (14) und einer zweiten Seite (16);

(b) einem Monopolstrahlungselement einschließlich einer ersten leitenden Spur (18), die auf der ersten Seite der Leiterplatte ausgebildet ist, wobei diese erste schmale leitende Spur eine physikalische Länge von einem Speiseende zu einem gegenüberliegenden Ende hat; und

(c) einem leitenden Element einschließlich einer zweiten leitenden Spur (20), breiter als die erste schmale leitende Spur, an der Leiterplatte angrenzend an, und parallel zu der ersten schmalen leitenden Spur und einen wesentlichen Abschnitt davon überlappend, wobei die zweite leitende Spur eine physikalische Länge von einem Masseende zu einem gegenüberliegenden Ende hat;

wobei die zweite leitende Spur die Masseebene oberhalb des Speiseendes (26) der ersten schmalen leitenden Spur verlängert und wobei das gegenüberliegende Ende der zweiten leitenden Spur einen virtuellen Speisepunkt des Monopolabstrahlelementes definiert, hierdurch die Bandbreite erhöhend, innerhalb der das Monopolabstrahlelement mitschwingt.

2. Gedruckte Monopolantenne nach Anspruch 1, wobei die zweite leitende Spur an der zweiten Seite der Leiterplatte ausgebildet ist.

3. Gedruckte Monopolantenne nach Anspruch 1, wobei die zweite leitende Spur an der ersten Seite der Leiterplatte ausgebildet ist.

4. Gedruckte Monopolantenne nach Anspruch 1, wobei die zweite leitende Spur das Abgestrahltwerden von Strömen über den wesentlichen Abschnitt der ersten leitenden Spur, den die zweite leitende Spur überlappt, verhindert.

5. Gedruckte Monopolantenne nach Anspruch 1, wobei die Leiterplatte aus flexiblem dielektrischem Material hergestellt ist.

6. Gedruckte Monopolantenne nach Anspruch 1, wobei die elektrische Länge der ersten leitenden Spur die Mittenfrequenz des Antennenbetriebs innerhalb eines ersten Frequenzbandes definiert.

7. Gedruckte Monopolantenne nach Anspruch 1, wobei die physikalische Länge der zweiten leitenden Spur die Impedanzanpassung für den Breitbandbetrieb der Antenne bestimmt.

8. Gedruckte Monopolantenne nach Anspruch 1, wobei die Leiterplatte, die erste leitende Spur und die zweite leitende Spur umformt sind.

9. Gedruckte Monopolantenne nach Anspruch 1, wobei der wesentliche Abschnitt der ersten leitenden

Spur nichtlinear ist, wobei die physikalische Länge der ersten leitenden Spur geringer ist als eine elektrische Länge für diese erste leitende Spur.

10. Gedruckte Monopolantenne nach Anspruch 9, wobei der nichtlineare Abschnitt der ersten leitenden Spur eine Rechteckwellenkonfiguration hat.

11. Gedruckte Monopolantenne nach Anspruch 1, außerdem einen Speiseanschluss (38) einschließend einschließlich eines Signalspeiseabschnittes (36) und eines Masseabschnittes (46), wobei der Signalspeiseabschnitt mit dem Speiseende der ersten leitenden Spur gekoppelt ist und der Masseabschnitt mit dem Masseende der zweiten leitenden Spur gekoppelt ist.

12. Gedruckte Monopolantenne nach Anspruch 11, wobei der Speiseanschluss einen Koaxialverbinder umfasst.

13. Gedruckte Monopolantenne nach Anspruch 1, wobei das monopolstrahlende Element eine elektrische Länge im wesentlichen äquivalent zur physikalischen Länge der ersten leitenden Spur hat.

14. Gedruckte Monopolantenne nach Anspruch 1, wobei die physikalische Länge der zweiten leitenden Spur geringer ist als die physikalische Länge der ersten leitenden Spur.

15. Gedruckte Monopolantenne nach Anspruch 1, wobei die elektrische Länge der ersten leitenden Spur annähernd äquivalent zu der Rechteckwellenlänge einer gewünschten Mittenfrequenz für den Antennenbetrieb ist.

16. Gedruckte Monopolantenne nach Anspruch 1, wobei eine elektrische Länge der ersten leitenden Spur annähernd äquivalent einer halben Wellenlänge einer gewünschten Mittenfrequenz für den Antennenbetrieb ist.

17. Gedruckte Monopolantenne nach Anspruch 1, außerdem einschließend:

    (a) eine zweite Leiterplatte (52) mit einer ersten Seite (54) und einer zweiten Seite, die zweite Leiterplatte beabstandet von der ersten Leiterplatte derart, dass die erste Seite der ersten Leiterplatte angrenzt an die zweite Seite der zweiten Leiterplatte;

    (b) eine dritte leitende Spur (50), ausgebildet an der ersten Seite der zweiten Leiterplatte;

    wobei die erste leitende Spur eine elektrische Längenresonanz hat innerhalb eines ersten Frequenzbandes und die dritte leitende Spur eine elektrische Längenresonanz innerhalb eines zweiten Frequenzbandes hat.

18. Gedruckte Monopolantenne nach Anspruch 1, außerdem eine dritte leitende Spur (50) umfassend, ausgebildet an der ersten Seite der Leiterplatte angrenzend an die erste leitende Spur, wobei die erste leitende Spur eine elektrische Längenresonanz innerhalb eines ersten Frequenzbandes hat und die dritte leitende Spur eine elektrische Längenresonanz innerhalb eines zweiten Frequenzbandes hat.

19. Gedruckte Monopolantenne nach Anspruch 1, außerdem ein parasitäres Element (56) einschließend, das ausgebildet ist an der zweiten Seite der Leiterplatte, wobei das parasitäre Element angeordnet ist an dem Ende gegenüber der zweiten leitenden Spur, wobei die erste leitende Spur eine elektrische Längenresonanz innerhalb eines ersten Frequenzbandes hat und das parasitäre Element die erste leitende Spur abstimmt auf eine zweite Resonanz innerhalb eines zweiten Frequenzbandes.

20. Antenne (10) für eine Kommunikationseinrichtung, ein eine Massenebene (21) definierendes Gehäuse 48 für diese Kommunikationseinrichtung, einschließlich:

    (a) eines Speiseanschlusses (36) einschließlich eines Signalspeicherabschnitts (36) und eines Massenabschnitts (46);

    (b) eine Leiterplatte (12) mit einer ersten Seite (14) und einer zweiten Seite (16);

    (c) ein monopolstrahlendes Element einschließlich einer ersten schmalen leitenden Spur (18) ausgebildet an der ersten Seite der Leiterplatte, wobei die erste schmale leitende Spur eine physikalische Länge von einem Speiseende, das mit dem Signalspeiseabschnitt des Speiseanschlusses gekoppelt ist zu einem gegenüberliegenden Ende hat;

    (d) ein leitendes Element einschließlich einer zweiten leitenden Spur (20), breiter als die erste schmale leitende Spur und ausgebildet an der Leiterplatte parallel zu der ersten schmalen leitenden Spur und einen Abschnitt hiervon überlappend, wobei die zweite leitende Spur eine physikalische Länge von einem Masseende hat, das gekoppelt ist mit dem Masseabschnitt des Speiseanschlusses zu einem gegenüberliegenden Ende, wobei das Masseende der zweiten leitenden Spur angeordnet ist am selben Ende wie das Speiseende der ersten lei-

tenden Spur;

wobei die zweite leitende Spur die Masseebene oberhalb des Speiseendes (26) der ersten schmalen leitenden Spur verlängert und wobei ein gegenüberliegendes Ende der zweiten leitenden Spur einen virtuellen Speisepunkt (22) der Antenne definiert, wodurch die Bandbreite erhöht wird, innerhalb der das Monopolabstrahlelement mitschwingt.

21. Antenne nach Anspruch 20, wobei die zweite leitende Spur das Abstrahlen von Strömen über den Abschnitt der ersten leitenden Spur, der ausgerichtet ist mit der zweiten leitenden Spur, verhindert.

22. Antenne nach Anspruch 20. wobei die zweite leitende Spur ausgebildet ist auf der zweiten Seite der Leiterplatte.

23. Antenne nach Anspruch 20, wobei die zweite leitende Spur in ihrer Größe bemessen ist, um eine Impedanzanpassung mit der ersten leitenden Spur bereitzustellen.

24. Antenne nach Anspruch 20, wobei die physikalische Länge der zweiten leitenden Spur in ihrer Größe bemessen ist zum Bereitstellen einer Impedanzanpassung mit der ersten leitenden Spur.

25. Antenne nach Anspruch 20, wobei der Abschnitt der ersten leitenden Spur, der ausgerichtet ist mit der zweiten leitenden Spur, nichtlinear ist.

Revendications

1. Antenne de type monopôle imprimée (10) ayant un plan de masse (21) défini de façon sensiblement perpendiculaire à celle-ci, comportant :

   (a) une carte de circuit imprimé (12) ayant une première face (14) et une seconde face (16) ;
   (b) un élément rayonnant de type monopôle comportant une première trace conductrice (18) formée sur la première face de ladite carte de circuit imprimé, ladite première trace conductrice étroite ayant une longueur physique allant d'une extrémité formant source primaire à une extrémité opposée ; et
   (c) un élément conducteur comportant une seconde trace conductrice (20) plus large que ladite première trace conductrice étroite formée sur ladite carte de circuit imprimé de façon adjacente, parallèle, et superposée à une partie importante de ladite première trace conductrice étroite, ladite seconde trace conductrice ayant une longueur physique allant d'une extrémité de mise à la masse à une extrémité opposée ;

   dans laquelle ladite seconde trace conductrice s'étend du plan de masse, au-dessus de l'extrémité formant source primaire (26) de la première trace conductrice étroite, et l'extrémité opposée de ladite seconde trace conductrice définissant un point de source primaire virtuelle (26) dudit élément rayonnant de type monopôle, afin d'augmenter ainsi la largeur de bande à l'intérieur de laquelle résonne ledit élément rayonnant de type monopôle.

2. Antenne de type monopôle imprimée selon la revendication 1, dans laquelle ladite seconde trace conductrice est formée sur ladite seconde face de ladite carte de circuit imprimé.

3. Antenne de type monopôle imprimée selon la revendication 1, dans laquelle ladite seconde trace conductrice est formée sur ladite première face de ladite carte de circuit imprimé.

4. Antenne de type monopôle imprimée selon la revendication 1, dans laquelle ladite seconde trace conductrice empêche des courants de rayonner sur la partie importante de ladite première trace conductrice superposée à ladite seconde trace conductrice.

5. Antenne de type monopôle imprimée selon la revendication 1, dans laquelle ladite carte de circuit imprimé est constituée d'un matériau diélectrique souple.

6. Antenne de type monopôle imprimée selon la revendication 1, dans laquelle la longueur électrique de ladite première trace conductrice définit la fréquence centrale de fonctionnement de l'antenne à l'intérieur d'une première bande de fréquences.

7. Antenne de type monopôle imprimée selon la revendication 1, dans laquelle ladite longueur physique de ladite seconde trace conductrice détermine l'adaptation d'impédance pour un fonctionnement à large bande de ladite antenne.

8. Antenne de type monopôle imprimée selon la revendication 1, dans laquelle ladite carte de circuit imprimée, ladite première trace conductrice, et ladite seconde trace conductrice sont surmoulées.

9. Antenne de type monopôle imprimée selon la revendication 1, dans laquelle la partie importante de ladite première trace conductrice est non linéaire, d'où il résulte que ladite longueur physique de ladite première trace conductrice est inférieure à une longueur électrique pour ladite première trace conductrice.

10. Antenne de type monopôle imprimée selon la re-

vendication 9, ladite partié non linéaire de ladite première trace conductrice ayant une configuration d'onde carrée.

11. Antenne de type monopôle imprimée selon la revendication 1, comportant en outre un accès pour source primaire (38) comportant une partie formant source primaire de signal (36) et une partie formant masse (46), ladite partie formant source primaire de signal étant couplée à ladite extrémité formant source primaire de ladite première trace conductrice et ladite partie formant masse étant couplée à ladite extrémité de mise à la masse de ladite seconde trace conductrice.

12. Antenne de type monopôle imprimée selon la revendication 11, dans laquelle ledit accès pour source primaire comprend un connecteur coaxial.

13. Antenne de type monopôle imprimée selon la revendication 1, dans laquelle ledit élément rayonnant de type monopôle a une longueur électrique sensiblement équivalente à ladite longueur physique de ladite première trace conductrice.

14. Antenne de type monopôle imprimée selon la revendication 1, dans laquelle la longueur physique de ladite seconde trace conductrice est inférieure à la longueur physique de ladite première trace conductrice.

15. Antenne de type monopôle imprimée selon la revendication 1, dans laquelle la longueur électrique de ladite première trace conductrice est approximativement équivalente au quart de la longueur d'onde d'une fréquence centrale souhaitée pour le fonctionnement de l'antenne.

16. Antenne de type monopôle imprimée selon la revendication 1, dans laquelle la longueur électrique de ladite première trace conductrice est approximativement équivalente à la moitié de la longueur d'onde d'une fréquence centrale souhaitée pour le fonctionnement de l'antenne.

17. Antenne de type monopôle imprimée selon la revendication 1, comportant en outre :

(a) une seconde carte de circuit imprimé (52) ayant une première face (54) et une seconde face, ladite seconde carte de circuit imprimé étant espacée de ladite première carte de circuit imprimé de telle façon que ladite première face de ladite carte de circuit imprimé soit adjacente à ladite seconde face de ladite seconde carte de circuit imprimé ; et
(b) une troisième trace conductrice (50) formée sur ladite première face de ladite seconde carte de circuit imprimé ;

dans laquelle ladite première trace conductrice a une longueur électrique résonante à l'intérieur d'une première bande de fréquences et ladite troisième trace conductrice a une longueur électrique résonante à l'intérieur d'une seconde bande de fréquences.

18. Antenne de type monopôle imprimée selon la revendication 1, comportant en outre une troisième trace conductrice (50) formée sur ladite première face de ladite carte de circuit imprimée de façon adjacente à ladite première trace conductrice, ladite première trace conductrice ayant une longueur électrique résonante à l'intérieur d'une première bande de fréquences et ladite troisième trace conductrice ayant une longueur électrique résonante à l'intérieur d'une seconde bande de fréquences.

19. Antenne de type monopôle imprimée selon la revendication 1, comportant en outre un élément parasite (56) formé sur ladite seconde face de ladite carte de circuit imprimé, ledit élément parasite étant situé à ladite extrémité opposée de ladite seconde trace conductrice, ladite première trace conductrice ayant une longueur électrique résonante à l'intérieur d'une première bande de fréquences et ledit élément parasite accordant ladite première trace conductrice a une résonance secondaire à l'intérieur d'une seconde bande de fréquences.

20. Antenne (10) destinée à un dispositif de communication, un boîtier (48) pour ledit dispositif de communication définissant un plan de masse (21), comportant :

(a) un accès pour source primaire (36) comportant une partie formant source primaire de signal (36) et une partie formant masse (46) ;
(b) une carte de circuit imprimé (12) ayant une première face (14) et une seconde face (16) ;
(c) un élément rayonnant de type monopôle comportant une première trace conductrice étroite (18) formée sur ladite première face de ladite carte de circuit imprimé, ladite première trace conductrice étroite ayant une longueur physique allant d'une extrémité formant source primaire couplée à ladite partie formant source primaire de signal dudit accès pour source primaire, à une extrémité opposée ;
(d) un élément conducteur comportant une seconde trace conductrice (20) plus large que la première trace conductrice étroite formée sur ladite carte de circuit imprimé de façon parallèle et superposée à une partie de ladite première trace conductrice étroite, ladite seconde trace conductrice ayant une longueur physique allant

d'une extrémité de mise à la masse couplée à ladite partie formant masse dudit accès pour source primaire, à une extrémité opposée, ladite extrémité de mise à la masse de ladite seconde trace conductrice étant située à la même extrémité que ladite extrémité formant source primaire de ladite première trace conductrice ;

ladite seconde trace conductrice prolongeant le plan de masse au-dessus de l'extrémité formant source primaire (26) de ladite première trace conductrice étroite et une extrémité opposée de ladite seconde trace conductrice définissant un point formant source primaire virtuelle (22) de l'antenne afin d'accroître ainsi la largeur de bande à l'intérieur de laquelle résonne l'élément rayonnant de type monopôle.

21. Antenne selon la revendication 20, dans laquelle ladite seconde trace conductrice empêche des courants de rayonner sur la partie de ladite première trace conductrice qui est alignée avec ladite seconde trace conductrice.

22. Antenne selon la revendication 20, dans laquelle ladite seconde trace conductrice est formée sur ladite seconde face de ladite carte de circuit imprimé.

23. Antenne selon la revendication 20, dans laquelle ladite seconde trace conductrice est dimensionnée de façon à assurer une adaptation d'impédance avec ladite première trace conductrice.

24. Antenne selon la revendication 20, dans laquelle la longueur physique de ladite seconde trace conductrice est dimensionnée de façon à assurer une adaptation d'impédance avec ladite première trace conductrice.

25. Antenne selon la revendication 20, dans laquelle la partie de ladite première trace conductrice qui est alignée avec ladite seconde trace conductrice est non linéaire.

FIG. 3

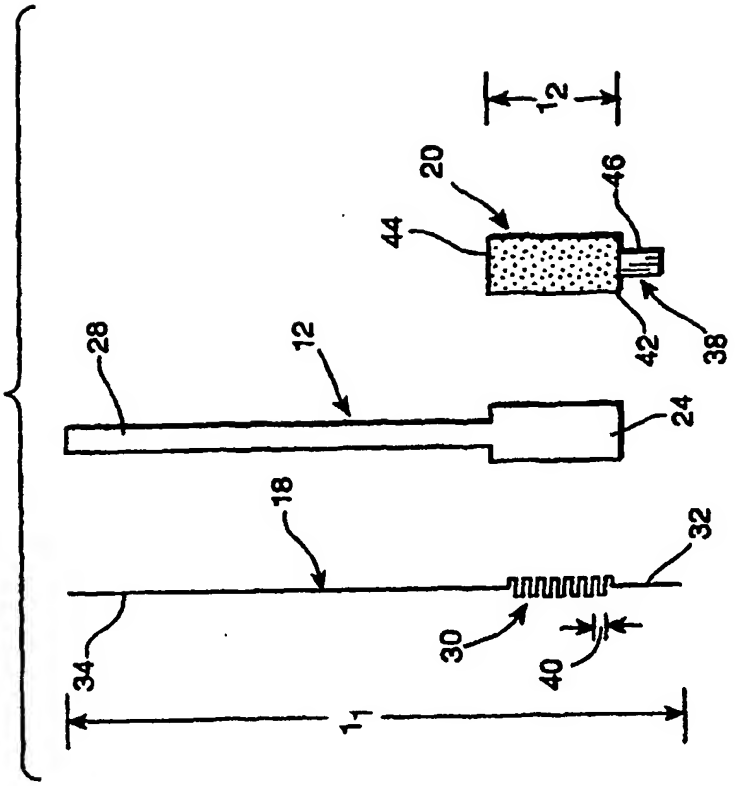

FIG. 2

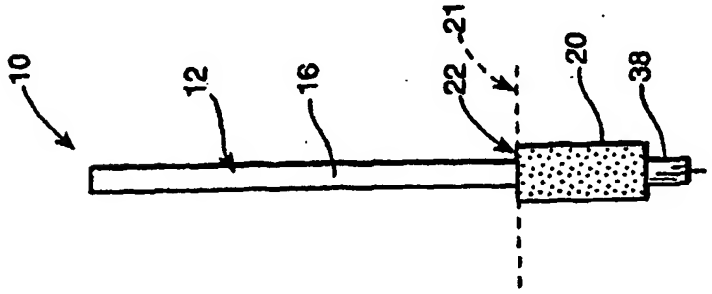

FIG. 1

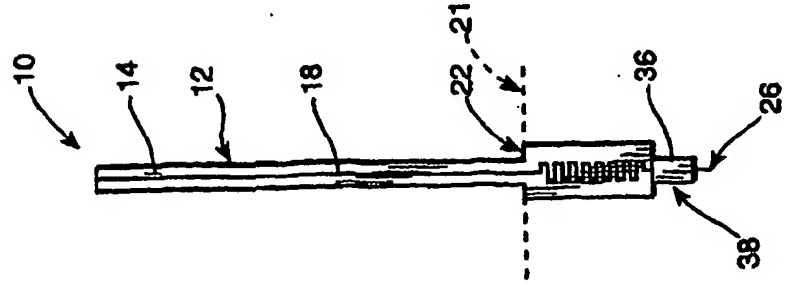

FIG. 6

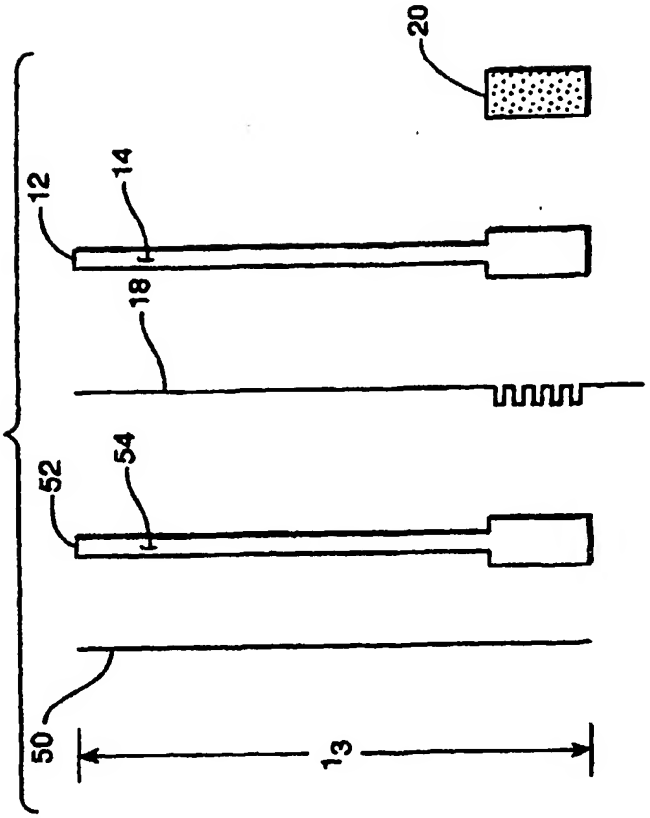

FIG. 5

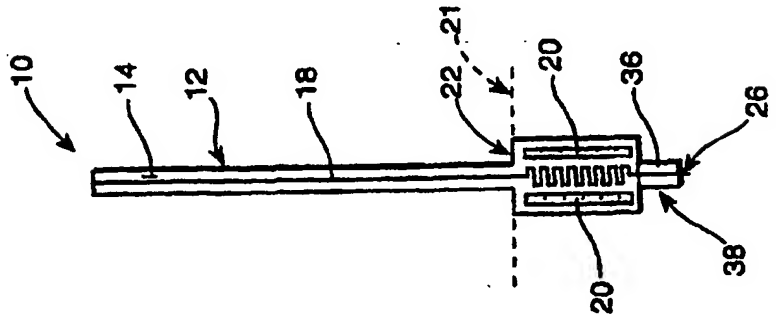

FIG. 4

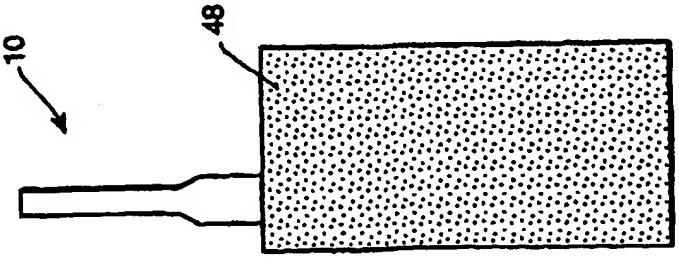

FIG. 8

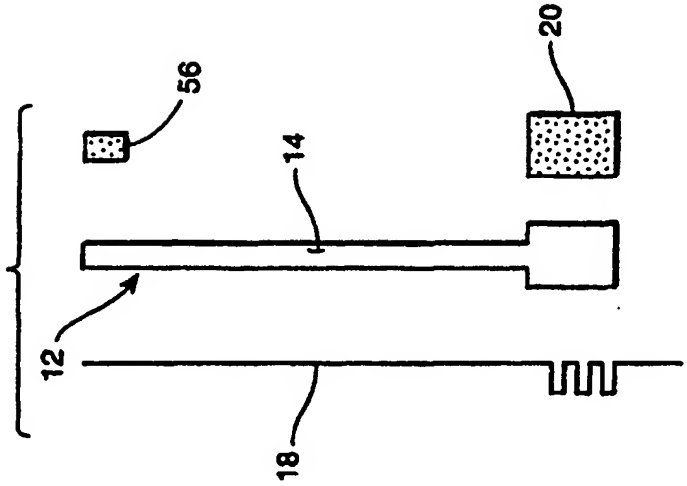

FIG. 7